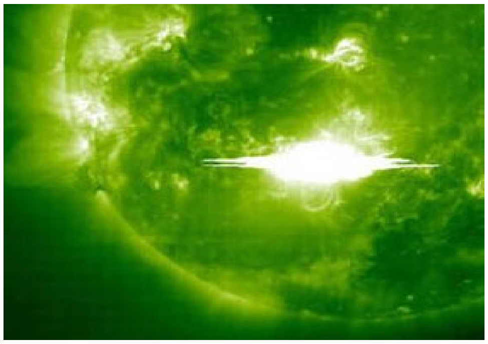
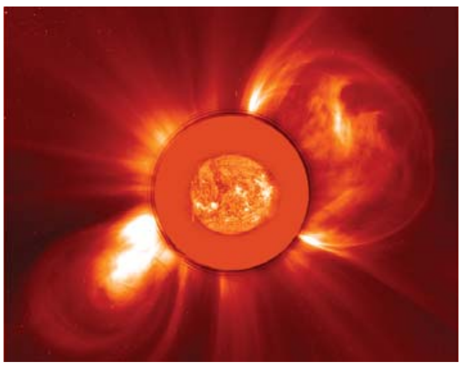
Systems of Equations in Space Science





Solving a system of three equations in three unknowns can commonly be found in several space science and astronomy applications.

Solar flares are a frequent phenomenon on the sun, especially during the peaks of solar activity cycles. Over 21,000 can occur during an average solar cycle period of 11 years! In our first problem, you will determine the average intensity of three classes of flares ('C', 'M' and 'X') by using statistical information extracted from three solar activity (sunspot!) cycles.

During February 4 - 6, 2000 the peak month of Cycle 23 solar scientists tallied 37 C-class, 1 M-class and 1 X-class flares, for a total x-ray intensity of 705 mFU (1 mFU = 10^{-6} watts/m^2) .

During March 4 - 6, 1991 scientists tallied 15 C-class, 14 M-class and 4 X-class flares for a total x-ray intensity of 2775 mFU

During April 1 - 3, 2001 scientists tallied 5 C-class, 9 M-class and 4 X-class flares for a total x-ray intensity of 2475 mFU.

Problem 1: Solve this system of equations and determine the average intensity of flares, to the nearest tenth, in each category (C, M and X) in units of mFU.

Communications satellites use electrical devices called transponders to relay TV and data transmissions from stations to satellite subscribers around the world. There are two basic types: K-band transponders operate at frequencies of 11-15 GHz and C-band transponders operate at 3-7 GHz. Satellites come in a variety of standard models, each having its own power requirements to operate its pointing and positioning systems. The following satellites use the same satellite model:

Satellite 1 : Anik F1
Total power = 15,000 watts
Number of K-band transponders = 48
Number of C-band transponders = 36

Satellite 2 : Galaxy IIIc
Total power = 14,900 watts
Number of K-band transponders = 53
Number of C-band transponders = 24

Satellite 3 : NSS-8
Total power = 16,760 watts
Number of K-band transponders = 56
Number of C-band transponders = 36

Problem 2: Use the data to determine the average power, to the nearest iteger, of a K-band and a C-band transponder, and the satellite operating power, F, in watts.

Answer Key:

After setting up the problems as a matrix, you might want to use the spiffy online matrix calculator at http://www.bluebit.gr/matrix-calculator/

Problem 1:

The system of equations is

31 C + 1 M + 1 X = 705
15 C + 14 M + 4 X = 2775
5 C + 9 M + 4 X = 2475

Matrix:

31	1	1
15	14	4
5	9	4

Inverse:

0.031	0.008	-0.016
-0.062	0.184	-0.169
0.101	-0.425	0.650

Solution:

C : 0.031 x 705 + 0.008 x 2775 -0.016 x 2475 = 4.5 mFU
M: -0.062 x 705 + 0.185 x 2775 -0.169 x 2475 = 51.4 mFU
X: 0.101 x 705 -0.425 x 2775 +0.650 x 2475 = 500.2 mFU

Problem 2.

Solving for satellite transponder power, K and C, and satellite operating power, F using 3 equations in three variables. From the satellite data

48 K + 36 C + F = 15,000
53 K + 24 C + F = 14,900
56 K + 36 C + F = 16,760

Matrix:

48	36	1
53	24	1
56	36	1

Inverse:

-0.125	0.0	0.125
0.031	-0.083	0.052
5.875	3.00	-7.875

Solution = -0.125 x 15000 + 0.125 x 16,760 = K = 220 watts per K-band transponder

0.031 x 15000 - 0.083 x 14,900 + 0.052 x 16,760 = C = 100 watts per C-band transponder

5.875 x 15000 + 3 x 14,900 - 7.875 x 16,760 = F = 840 watts for the satellite operating power